IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

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Accident at the FUKUSHIMA DAI-ICHI nuclear power plant

Assessment of the situation in February 2012

This document is based on information publicly available concerning the situation at the Fukushima Dai-ichi power plant.

I. Background

The earthquake of magnitude 9 that occurred on 11 March 2011, 80 km east of the island of Honshu in Japan, and the tsunami that followed, severely affected Japanese territory in the region of Tohoku, with major consequences for the population and infrastructures.

In devastating the site of the Fukushima Dai-ichi nuclear power plant (NPP), these natural events led to the core meltdowns in three nuclear reactors[1] and the loss of cooling in several spent fuel storage pools. Explosions also occurred in the buildings of reactors 1 to 4 due to production of hydrogen during fuel deterioration. Very important radioactive releases into the environment occurred. The accident was classified at level 7 on the INES scale.

II. State of the facilities

- Cores of reactors 1, 2 and 3

From the outset, the information available about the accident led IRSN to conclude that fuel from the three reactors had partially melted as a result of the loss of cooling. Although there was no clear evidence to suggest there had been significant rupture in the core vessels after corium was probably transferred to the bottom of the vessels, IRSN considered the integrity of the vessels and the containment structure to be no longer guaranteed.

Analyses conducted by TEPCO have since concluded that:

- for reactor n°1, total meltdown of the core and rupture of the core vessel has occurred, with corium spreading into the bottom of the containment structure;
- for reactors n°2 and n°3, significant deterioration of the cores has occurred, with the possibility of significant transfer of corium to the bottom of the vessel and a slight flow of this corium to the bottom of the containment structure.

- Spent fuel storage pools

The information available (video monitoring of the interior of the pools and measurements of water contamination) supports the hypothesis that there was no significant deterioration of the spent fuel stored.

[1] Reactor n°4 has been unloaded and reactors n°5 and n°6 have been placed in a safe shutdown state.

However, material fell into the pools of reactors n°1, n°3 and n°4 following the explosions, which will complicate the extraction of the spent fuel present in the pools.

III. Current status of the facilities

Reactors n°1, n°2 and n°3 are being cooled by injection of fresh water (approximately 10m^3/hr). TEPCO reported at the end of 2011 that a "cold shutdown" situation had been achieved (an inappropriate term given the status of the reactors) with a water temperature in the reactors below 100°C. This limits water evaporation and thus reduces releases into the environment by containment leaks. In addition, nitrogen is injected into the containment vessels of the reactors to maintain inerting and thus avoid any risk of hydrogen combustion.

The storage pools of the six reactors and the site storage pool are now cooled in a closed circuit. In addition, TEPCO has carried out work to improve the civil engineering of the reactor n°4 pool as part of its plan to regain control of the facilities.

In order to stabilise the status of the facilities, TEPCO has established redundant equipment and electrical backup systems to maintain cooling of the facilities and ensure nitrogen inerting of the reactor containment buildings. In addition, some equipment has been installed in elevated areas and anti-tsunami protection has been established at the site boundary. Finally, monitoring of crucial parameters is ensured (water temperature, hydrogen level in the containment systems, water levels, etc.). **IRSN acknowledges that TEPCO has implemented considerable resources in order to regain control of the facilities and reiterates that these actions should be maintained in the long term, considering the time necessary to dismantle the facilities.**

Various events have been encountered over time (rise in xenon level, drift in temperature measurements, leaks from water circuits, etc.) which, given the information available, have not revealed a significant variation in the status of the facilities. **IRSN stresses however that these factors confirm the need to maintain vigilance as to the behaviour of the facilities, in a context that is still difficult due to limited accessibility and the uncertain reliability of the monitoring methods. In any event, the activities conducted by TEPCO in the facilities will inevitably lead to the discovery of new factors.**

IV. Present radioactive releases

In light of the available information, diffuse releases continue (several tens of MBq of caesium/hr in December 2011, according to TEPCO), but they are not comparable to those that occurred in mid-March 2001.

TEPCO continues its activities aiming to control these diffuse releases, in particular:

- by fixing the contamination of the outside grounds and buildings (spraying resin);
- by covering the reactor buildings with walls fixed on a metal framework (done for reactor n°1);
- by sealing off some underground technical installations and installing an underground wall between the site and the ocean (in progress);
- by treating the water present in the low portion of the buildings (at the end of December 2011, almost 200,000 tons of water have been treated).

V. Plan to regain control of the facilities

TEPCO considers that the first phases of regaining control of the facility have been completed, inasmuch as cooling is provided for the reactors and the pools, with a low water temperature maintained in the facilities, and residual releases are at low levels. Cleanup activities on the site are continuing, in particular to allow future work.

The action plan chosen by TEPCO now includes three major steps:

- the first is to start the removal of the fuel in the pools of reactors 1 to 4, with a target of 2 years;
- the second undertakes the removal of the deteriorated fuel from reactors 1 to 3, with a target of 10 years;
- the last will lead to complete dismantling of the facilities, with a target of 30 to 40 years.

This action plan is combined with a significant research and development programme to specify and organise the procedures to be carried out, which are major in scale and without precedent.

Without questioning the consistency of this action plan, IRSN stresses that the deadlines announced can only be considered orders of magnitude and that major, in-depth operations will have to be undertaken to establish the status of the facilities.